biology are subdivisions of the broader science of chemistry." Should it not be possible to find a core of this work which is essential chemistry and teach that?

The physics people have met the challenge concerning boundaries and disputed territory courageously. It is not long since I heard a university professor begin a lecture on physics somewhat in this way: "Physics is the science of matter and energy. This field is so large that it is customary at present to break off the physics of the molecule and its reactions and call it chemistry. Also to put to one side the physics of the heavenly bodies and call this part astronomy," etc. So these two subjects, physics and chemistry, have been mutually devouring each other, like two Kilkenny cats, lo these many years. It seems to have been good for them, however, for both have grown to be lusty fellows. The only difficulty seems to be to determine which is which. Suppose we give up trying, call the amalgamated science what you like, and frankly make a two-years course in this science, with the topics arranged in logical order, as an elementary book for high schools. This would dispose of the not very important but still much discussed question whether chemistry should come in the eleventh or the twelfth year, as well as the far more important matter of extensive duplication. At first sight it might seem desirable to repeat a large amount of physics in the chemistry classes, especially as this part is in general very important, but a moment's thought will convince any one—not already convinced by experience—that this is not likely to be true. The work presses; the class will meet these subjects elsewhere; nobody is responsible for a full presentation of them; and so the few ideas most essential to further progress are made to suffice. There is no one to apply the excellent homestead law—one must not only stake out a field but occupy and do some work upon it.

If a two-years' unitary course in physical science can not be secured, some competent authority—say a joint committee of the chemical and physical societies of America—might be asked to say what shall be taught as chemistry and what as physics. For instance, where shall the modern doctrine of solutions be taught? How much of combustion, of electrolysis, of the action of a primary battery, is chemistry and how much physics?

E. A. STRONG

## SCIENTIFIC BOOKS

*Physical Optics.* By ROBERT W. WOOD, LL.D., Professor of Experimental Physics in Johns Hopkins University. Second Edition. New York, The Macmillan Company. 1911. Pp. xvi + 705. Price $5.25 net.

To those who are acquainted with the earlier edition of Wood's "Physical Optics" it will be high and just praise of the second edition merely to say that it is vastly superior to the first. The new material added to the former discussion—roughly, fifty per cent.—illustrates the tremendous recent development of physical optics; and the manner in which all this work is described continues to illustrate the extraordinary clarity and precision with which intricate matters may be set forth, in a non-mathematical way, by a man who really and profoundly understands his subject.

Of the various additions and improvements, perhaps the following will serve to characterize the whole:

The first three chapters have not been much altered, although they do contain some new material, such as the work of Galitzin and Wilip on Döppler's principle, Pfund's mercury arc, etc.

A very characteristic addition finds place in the fourth chapter, the one dealing with refraction, where a series of photographs taken with a lens immersed in water—a "fish-eye camera"—has been inserted. These give a concreteness and directness to the treatment of the critical angle which could hardly be obtained in any other manner.

Chapter V., on dispersion, shows few changes, but is enriched by a plate showing Julius's remarkable series of photographs of the "D" lines, under various physical circumstances.

The value of the chapter on diffraction is

enhanced by an exposition of A. B. Porter's work on the nature of optical images, by the author's clever vectorial treatment of secondary maxima in grating spectra, by an account of the Echelette grating, and by a new viewpoint from which to regard Talbot's fringes —all of which have recently appeared in the *Philosophical Magazine*. The discussions of interference and polarization remain almost intact. A brief but entirely new chapter is here given to "Meteorological Optics."

The beautiful method of focal isolation by which Rubens and Wood have recently been enabled to measure heat waves which are more than one tenth of a millimeter in length, has been inserted in the chapter on the theory of dispersion. But this well illustrates the impossibility of keeping a treatise up to date; for notwithstanding the preface is dated May, 1911, the infra-red spectrum has since then been extended more than an octave and a half; so that now the gap between the electrical and optical spectra is something less than three octaves—the difference between a third of a millimeter and two millimeters.

Interesting additions, dealing with the absorption of gases, have been made to Chapter XV., including Wood's extension of Balmer's series for sodium vapor absorption lines to the 48th member.

The discussion of magneto-optics has been greatly and properly enlarged, and is followed by an entirely new chapter on electro-optics.

Chapter XX., dealing with fluorescence and related phenomena, has a long title of nine words which, in the opinion of your reviewer, might well be replaced with the single term "Photo-luminescence." The Laws of Radiation (Ch. 21) have been made to include the recent achievement of Lebedew in demonstrating experimentally that a beam of light exerts a definite pressure upon an absorbing gas.

The remainder of the volume differs little from the former edition except that a final chapter on the principle of relativity has been added. But to attempt an elementary exposition of the ideas of Einstein and Minkowski in twelve small pages is well nigh attempting the impossible. Lack of consecutiveness makes this last chapter the only unsatisfactory one in the entire volume.

Of the book as a whole it ought to be remarked that it teems with practical hints of great value, clever bits of experimental experience from the large fund for which the professor of experimental physics in Johns Hopkins University is justly celebrated. The policy of the author in maintaining a quantitative discussion throughout, and yet refraining from the use of very advanced or severe or complicated mathematical methods, is to be highly commended. It is a matter of constant surprise to find what a large proportion of all really important phenomena can be described by very simple differential equations and can be discussed by the ordinary analysis. This remark is, of course, only intended to apply to the mathematical method of a treatise for students of physics, and not to an original paper describing the results of a mathematical investigation.

A work so altogether admirable as this should not be marred by so many typographical errors and incomplete references. Sometimes one is referred merely to "*Phil. Mag.*," at other times, as for instance in Runge's exquisite treatment of the concave grating, p. 233, one is merely told that the discussion is "due to Runge." Economy of energy on the part of the reader will be greatly served by the correction of many of these slight matters in a future revision.

However views may diverge as regards the treatment of various topics in this volume, there can surely be no difference of opinion among English-speaking students as regards the generosity which Professor Wood has shown in taking time and energy from a strenuous life of research to prepare this clear, scholarly and thoroughly modern treatise. Appreciation of this can hardly fail to show itself in a long and wide-spread use of the book.

HENRY CREW

*Atlas of Zoogeography.* By J. G. BARTHOLOMEW, W. EAGLE CLARK and PERCY H. GRIMSHAW. Series title: *Bartholomew's Physical*